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The presented articles were prepared for an OeNB workshop and therefore a revised version may be published in other journals.

Comment on the Papers by Scharler et al. and by Redding et al.

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Both of these papers are related to the research field of endogenous growth and, more particularly, to the effects of inventions on economic growth.

In economics, *technological progress* means an increase in productivity, i.e. more output at the same-value of input. Part of it is caused by inventions (new products, new production technologies, or major changes of old technologies), part of it by learning-by-doing etc. Inventions can be rewarding to the inventor or to others who adopt the new creation. Inventions may be transferred, adapted, or imported. The (non-academic) literature as well as history are full of anecdotes on inventors who were unable to reap the profits that eventually arose from their ideas. A popular cartoon character, Gyro Gearloose, may serve as an example.

The presented papers contribute to several aspects of this general process:

1) improving the environment for inventions by investing into R&D (*research and development*)
2) importing the inventions created by others' R&D
3) improving the ability of adopting others' R&D

In the world of GRIFFITH, REDDING, VAN REENEN, technological progress is caused by own R&D and by "distance to a leading frontier economy". A lesser role is allotted to human capital, while the significance of trade (technology imports) remains low.

In the world of CRESPO-CUARESMA, FOSTER, SCHARLER, technological progress is caused by own R&D and by imported R&D. The reaction to imported R&D is analyzed in detail. Human capital *per se* is not considered. The significance of a "technology gap" to frontier economies remains low.

GRvR measure the technological progress by using a constructed TFP (*Total Factor Productivity*) variable. This variable is unobserved. Its construction relies on a production function specification. In that construction, measured inputs were modified. The dependent variable is a sophisticated construction.

CCFS measure technological progress by using GDP *per capita*. Increases in welfare that are not directly explained by labor quantity and physical capital are explained by R&D. The assumed production function is of a Cobb-Douglas type.

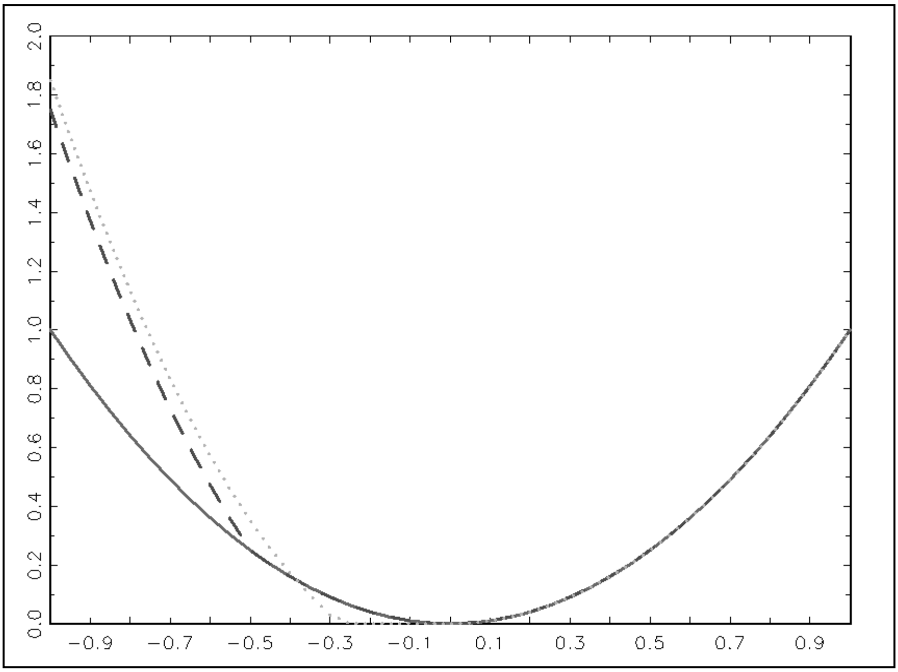
The dependent variable is a straightforwardly measured aggregate.

This evaluation of inherent sophistication should not be seen as a preference for the GRvR approach. Sophistication may be a virtue and it may be a problem. Simple techniques may succeed in highlighting features more clearly. Sophisticated constructions involve a larger risk due to potential weak points in the logical chain.

In more detail, I would like to concentrate on two features in the presented papers: firstly, the threshold model that was used by CCFS to characterize the slowdown in technological progress, as a point of satiation is approached; secondly, the inherent problem of time-series approaches in describing processes of economic convergence.

The threshold model relies on the main idea that convergence is faster while you are further away from the equilibrium. A good visual impression is provided by the curves in chart 1. A linear model corresponds to the movement of a particle in a parabolic cup, which obeys two kinds of forces: gravity and some `stochastic' perturbation that may be caused by filling the cup with some liquid or gas. A third force, inertia, can be represented in short-run autocorrelation corrections, in economic time-series models. To the left of the minimum, the particle tends to move right, while the tendency is reversed to the right of the minimum. Note that only the left side of the convergence mechanism is investigated in the paper.

Chart 1: Attraction Toward an Equilibrium in Linear and Broken Linear Models

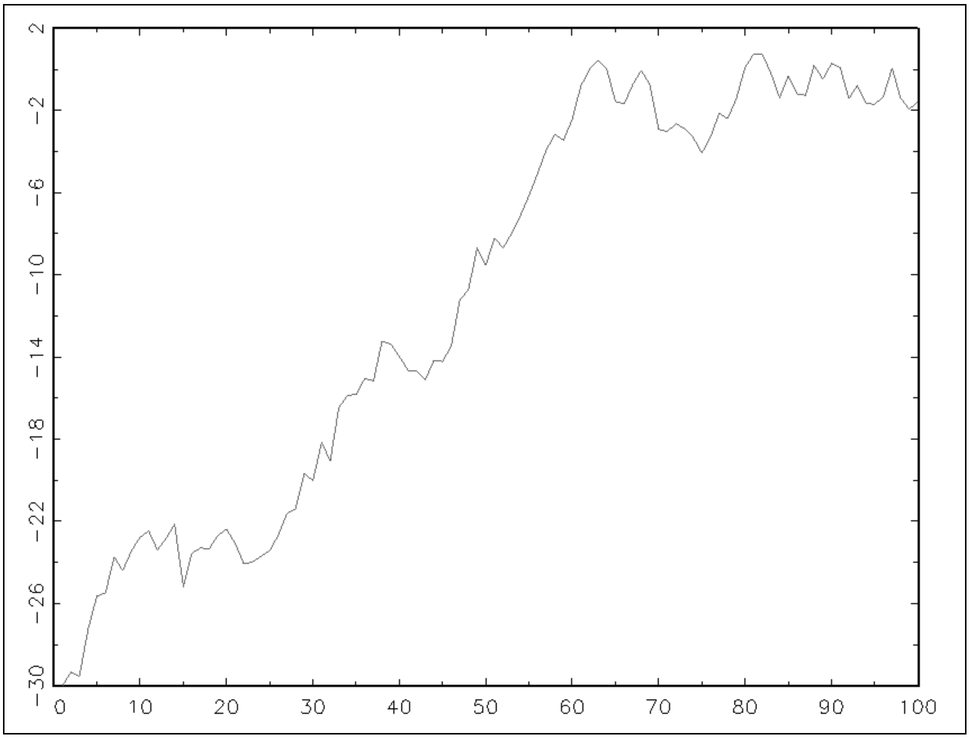


The solid curve depicts linear convergence, while the dashed one implies a threshold close to the equilibrium. The dotted curve is representative of a threshold process that is active only at a distance from the equilibrium. The curve is flat close to the bottom. In this case, there is a whole range of values that serves as an attractor, rather than a single point. It is a common misunderstanding that such an attractor area is equivalent to statistical expectation. Also for the dynamic behavior that is depicted by the dotted curve, usually a single point is the expected value for the position of the particle.

Another remark concerns the problem whether time-series models are able to describe economic convergence. It is obvious that some confusion has been introduced to the convergence literature, for example, by testing for cointegration in vector systems. It is often unclear whether cointegration indicates convergence or not. If two integrated processes are *not* cointegrated, there cannot be convergence. Trajectories may cross each other by chance, with no tendency to stay together from the time point of crossing. If two integrated processes are cointegrated, however, there cannot be convergence either. Their trajectories tend to develop in parallel movements, as some linear combination or simply their distance is stationary. It follows that, in the framework of time-series models, observed "convergence" is either a non-linear or a disequilibrium phenomenon.

High positive serial correlation and a starting value distant from the stationary equilibrium may lead to plausible modeling of disequilibrium phenomena ("convergence") even for linear autoregressions. The chart shows a threshold linear autoregression with $\varphi = 0.99$ and $\varphi = 0.98$. The stationary mean is 0, while the process is started from $X_0 = -30$.

Chart 2: A Trajectory from a Treshold Autoregressive Process with Strong Serial Correleation, Started from a Disequilibrium Value



Note, however, that absorption may not imply convergence. A country may lead others by its larger R&D capital stock persistently.

It may be interesting to simulate a joint system of a vector of economies. This should be a recommendation to many authors of empirical papers. Following the identification of a plausible dynamic model and estimation of its free parameters, trajectories from the implied `reality' should be simulated by Monte Carlo methods. A simple visual comparison of the simulated trajectories and the observed data reveals most data features that have not been captured by the model. Such features, in turn, may provide a guideline for a potential revision of the modeling ideas.